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Different patterns of knowledge spillovers mechanisms in two Mexican localities

Claudia De Fuentes[1]

Abstract

Several papers from different bodies of literature have analyzed the knowledge spillover mechanisms from large firms, mainly multinational corporations (MNC), to local firms. However, most of them have not analyzed the differences within a sector or locality; they have neither compared the specific patterns of knowledge spillover mechanisms in two different localities. This can be explained to the difficulty to obtain databases to compare the same phenomenon in two different localities. The aim of this paper is to identify the most important knowledge spillover mechanisms within the same sector in two different localities. Particularly this study analyzes the machining sector industry located in Querétaro and Ciudad Juárez, México. To identify the variables that can explain the knowledge spillover mechanisms we perform a multivariate analysis, using principal factor techniques. To identify the main knowledge spillover mechanisms and to explore their importance within the two localities we built a structural equation analysis. This paper argues the existence of different patterns of knowledge spillovers mechanisms in the localities analyzed. The productive arrangement, the main characteristics of SME´s and some characteristics specific to the context can explain the different patterns observed.

Introduction

During the past ten years there has been a growing interest in regard the analysis of knowledge spillovers and the main mechanisms that explain them. Different works from the foreign direct investment (FDI) literature have studied knowledge spillovers from

[1] Claudia De Fuentes González, PhD in Technology Development, UAM. Graduate program Economics and Management of Technical Change, UAM, claudiadefuentes@yahoo.com.mx

multinational companies (MNC) to local firms (Blomström and Sjöholm 1998; Girma, 2002; Chudnovsky, et al, 2003; Jordaan, 2005 and Marin and Bell, 2006). In spite of these important contributions, there are still some gaps in relation to the identification of the most important knowledge spillover mechanisms within a sector and locality.

Several studies from different bodies of literature have identified some spillover mechanisms (Albaladejo, 2001; Giuliani, 2005; Chudnovsky, et al, 2003; Dutrénit and Martínez, 2004; Vera-Cruz and Dutrénit, 2005; Jordaan, 2005; and Marin and Bell, 2006), such as: i) demostration-imitation; ii) human capital mobility; iii) increase in competence due changes in the market structure; iv) foreign linkages; iv) backward linkages; vi) training; and vii) direct technology transfer.

Most of the previous analysis has not analyzed the differences within a sector or locality; neither have they compared the specific patterns of knowledge spillover mechanisms in two different localities. This can be explained to the difficulty to obtain databases to compare the same phenomenon in two different localities. The main contribution of this paper is the analysis of two knowledge spillover mechanisms from large firms to SMEs within a specific sector in two different localities. Particularly we focus on the human capital mobility and backward linkages mechanisms.

The study focuses on the machining sector in two Mexican localities. Most of the firms that belong to this sector are small and medium (SMEs). They are suppliers of medium and large firms, mainly from the automotive, home appliances and electric-electronic sectors. Both of the localities analyzed present a highly industrial dynamics; they present some differences in terms of their institutional infrastructure.

One of the localities is Queretaro, which is located two hours far from Mexico City. This locality has several agents, such as firms, public research centers, universities, government agencies, and industrial associations. Some of the national and multinational large firms belong to the automotive and home appliances sectors. The other locality analyzed is Ciudad Juarez, Chihuahua. This border city with United States present an interesting

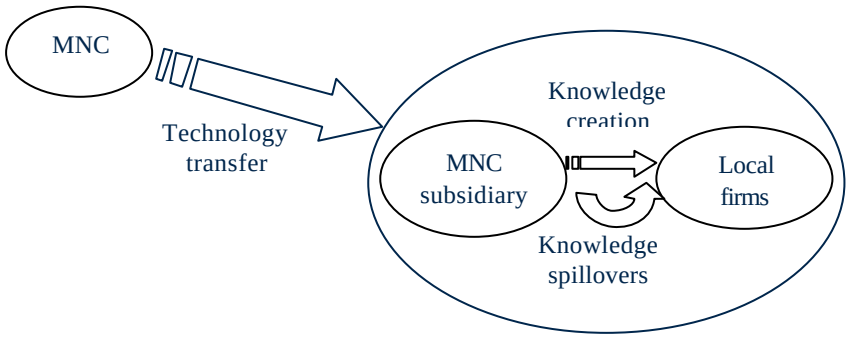
industrial dynamic due to the maquiladoras,[2] most of these are automotive and electric-electronic maquiladoras. The institutional infrastructure regarding public research centers is not as important as in Queretaro. The productive arrangement, the main characteristics of SMEs and the differences in the localities where firms are located, can impact the type and level of knowledge spillovers.

This paper is divided in four main sections. The first section discuses the theory and the main approaches to analyze the knowledge spillover mechanisms. The second section presents the methodology. The third section analyzes the main findings, and the fourth section presents the conclusions.

1. Knowledge spillovers and their main mechanisms

Multinational corporations (MNC) are embedded with technology knowledge, technological and organizational capacities and culture from the headquarters. These knowledge bases represent a competitive advantage to compete in local markets (Doz and Prahalad, 1984; Roth and Schweiger, 1991; Mockler, 2002 and Blomström and Kokko, 2003). Marin and Bell (2003 and 2006) emphasize the role of subsidiaries for knowledge spillovers. They argue that MNC subsidiaries can play an active role for the technological transfer, as they perform knowledge-based activities additional to the activities in yhe headquarters. Some of the knowledge generated in the subsidiaries is transferred to local enterprises (Figure 1).

Figure 1 Knowledge spillover process among MNC and local enterprises



Source: Author´s own.

[2] The maquiladoras imports materials and equipment on a duty-free basis for assembly or manufacturing and then re-export the assembled product.

Foreign direct investment (FDI) literature focuses its analysis on MNC knowledge spillovers to local firms. This document study large firms, either national or MNC and analyze their knowledge spillovers to local SMEs.

Blomström and Kokko (2003) refer to technology spillovers as the benefits that local firms get from product, process or market technologies from MNC. Even though most of the papers coming from the FDI literature refer to technology spillovers, we consider that knowledge spillovers captures better the spillover phenomenon from large firms to local firms, as it is possible to analyze technology and organizational knowledge that spills over local firms. Escribano, Fosfuri and Tribo (2005, p. 2) define knowledge spillovers as *"Involuntary knowledge flows which arise when part of the knowledge generated by an organization spills over its boundaries and becomes available to other organizations"*. We adapt the knowledge spillovers concept to analyze large firms´ spillovers –that can be either national or MNC, to local SMEs within a specific locality. We define knowledge spillovers as *"The organizational and technological benefits that local SME get from large firms knowledge flows, which can be either conscious or unconscious, and increase SME productivity.*

There are vertical and horizontal knowledge spillovers (Blomström and Sjöholm, 1998). If spillovers happen within the same sector, they are considered as horizontal spillovers (Aitken and Harrison, 1999; Girma and Wakelin, 2000; Girma, *et al*, 2000; Görg and Greenaway, 2001; Girma, 2002; Girma and Görg, 2002; Marin and Bell, 2003 and Chudnovsky, *et al*, 2003), in this specific case, large firms do not have incentives to promote spillovers (Sjöholm, 1999a and 1999b), as other firms can reap the benefits from their superior knowledge, becoming stronger competitors.

Knowledge spillovers are vertical or inter-sectorial if they occur across sectors (Aitken and Harrison, 1999; Kinoshita, 2000; Chung, *et al*, 2002; Chudnovsky, *et al* 2003; Marin and Bell, 2003 and Vera-Cruz and Dutrénit, 2005). Large firms can increase the competitive pressure of the industry; this is one of the main factors that increase the local firms´

productivity.[3] Those supplier firms that do not increase their technological and organizational capabilities loose business and eventually go out from the industry (Chung, *et al*, 2002; te Velde, 2002; Blomström and Kokko, 2003). In this specific case, large firms have incentives to promote knowledge spillovers, as they can get the benefits from the increases in productivity of their suppliers (Chung, *et al*, 2002 and Ivarsson and Göram, 2005). Large firms´ supplier strategy plays an important role for vertical knowledge spillovers (Altenburg, 2000).[4]

Knowledge spillovers are diffused through formal and informal channels (Blomström and Kokko, 2003), which can be divided into several mechanisms. There are some factors that promote the existence of such spillovers, such as the sector technology level and the geographic distance among firms.

1.1. Knowledge spillover mechanisms

Several papers from the FDI literature have made important contributions in regard the identification of knowledge spillovers (Blömstron and Kokko, 1996 and 2003; Aitken and Harrison, 1999; Girma, Greenaway and Wakelin, 2000; Chudnovsky, *et al*, 2003; Vera-Cruz and Dutrénit, 2005 and Jordaan, 2005): i) demonstration-imitation; ii) human capital mobility; iii) competence increase; iv) foreing linkages; v) backward linkages; vi) training; and vii) direct technology transfer. Some of the mechanisms identified by other authors are discussed below:

i. Demonstration-imitation: This is the most common type of spillover.[5] They usually occur when firms observe and copy and other firms´ processes, increasing their productivity.

[3] Chung, *et al* (2002) points out those local supplier activities became into a potential source for technology transfer from Japanese MNC to local firms. He observed vertical knowledge flows associated to production, engineering, price, delivery times, supervision, and other related activities. Japanese MNC provided technical and operative support to their suppliers, which usually increased their productivity.

[4] The following are the most important factors that large firms consider to identify for the selection and developing of local suppliers: i) quality and delivery time; ii) small pool of suppliers to reduce transaction cost; iii) local suppliers to reduce transport cost; iv) suppliers that share responsibility during product development; v) ability to solve problems (Mudambi and Helper, 1998; MacDuffie and Helper, 1997 and Dutrénit, 2003).

[5] Kim (1997).

ii. Human capital mobility: Large firms increase the human capital pool. Their employees, engineers and technicians develop organizational and technical abilities, acquiring important experience. Employees are embedded with the technology, knowledge, and organizational techniques and they are direct agents of technology transfer. This mechanism is one of the most important types of knowledge spillover.[6] This mechanism can be observed through: i) hiring employees highly qualified; and ii) entrepreneurship, creation of new firms by large firms´ former employees.

iii. Competence increase: Large firms can increase competence if they encourage local firms to reach their demands. Local firms take specific actions to maintain and increase their market shares.[7] To keep their market shares local firms use their technology and resources more efficiently to increase their productivity. Stronger competence can increase the imitation rates and the adoption of new technologies. Some authors argue that some firms´ productivity is reduced due to negative competence effects. Especially if they do not establish strategies to increase their technologies and organizational capacities.

iv. Foreign linkages: Firms can learn how to export from other firms with more experience. Exportation processes involves a deep knowledge in regard to markets, quality, specifications, etc. It is common for large firms to have that specific knowledge: Local firms can imitate their techniques and learn how to supply foreign markets.

v. Backward linkages: Backward linkages are mainly observed by: i) direct technology support, to reach customers demands; and ii) increase of specific requirements, local firms have to use their resources more efficiently to reach those specific requirements. The next mechanisms are related to the backward linkages mechanism.

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[6] Lara, Arellano and García (2003), emphasize that MNC such as the maquiladoras located in the border of Mexico and US promote the creation of SME by: i) strengthening of local providers; and ii) maquiladoras provide a critical pool of human capital, that benefit the creation and strengthening of local firms.

[7] Chung, *et al* (2002) argues that competitive pressure in the automotive sector is the main cause of productivity increase.

vi. Training: Backward linkages sometimes promote the training of key employees of supplier firms. The main purpose of this training is to increase their abilities to reach customer demands.

vii. Direct technology transfer: Backward linkages also promote direct technology transfer from large firms to their suppliers to reach certain requirements. The main objective is to increase their suppliers' production and technology capacities.

Table 1 sums up the knowledge spillover mechanisms described above, and classify them according to the diffusion channel and spillover channel.

Table 1 Knowledge spillover mechanisms

Mechanism	**Sources of productivity gain**	**Diffusion channel**	**Type of spillover**
Demonstration-Imitation	??Adoption of new production methodologies ??Adoption of new management practices	??Formal ??Informal	??Vertical ??Horizontal
Human capital mobility	??Increases in productivity ??Tacit knowledge	??Informal	??Vertical ??Horizontal
Competence increase	??Efficiency increase ??Faster adoption of new technologies	??Formal ??Informal	??Vertical ??Horizontal
Foreign linkages	??Economies of scale ??Exposition to international markets	??Formal ??Informal	??Vertical ??Horizontal
Backward linkages	??Support linkages ??Efficiency increase	??Formal	??Vertical
Training	??Tacit knowledge	??Formal	??Vertical
Direct technology transfer	??Increase in competitiveness	??Formal	??Vertical

Source: Adapted from Görg and Greenaway, 2001.

1.2. Factors that affect knowledge spillovers

Some factors can affect the scope and impact of knowledge spillovers. Two factors have been specially discussed, such as the technology level of firms, i.e. knowledge spillovers

are sector specific. Other factor that has been discussed is the geographic distance among firms.

a. Technology level

Knowledge spillovers are sector specific and they depend of the complexity of knowledge that is to be transferred (Girma and Wakelin, 2000 and Kinoshita, 2000).[8]

Some advanced sectors, such as electric, electronic, biotechnology, etc. have the potential to generate more knowledge spillovers since they employ more advanced human capital and develop more R&D activities. Sectors with low technology capacities, low competence levels and important technology gaps, have low a level of knowledge spillovers (Girma and Wakelin, 2000; Kinoshita 2000; Girma, 2002 and Marin and Bell, 2003). However, some authors have identified negative spillovers within highly innovative sectors. On the other hand, local firms that compete within less innovative sectors get positive spillovers (Blomström and Kokko, 1996 and Chudnovsky, *et al*, 2003).

b. Geographic distance among firms

Knowledge spillovers have a geographic component. Knowledge spillovers tend to be higher were large firms are located (Blomström and Kokko, 1996; Girma and Wakelin, 2000; Girma, 2002; Girma and Görg, 2002; Girma, 2003 and Jordaan, 2005).

Two main factors explain this: i) direct contact minimize transport cost and increase communication and interaction among firms within the same region; ii) the mechanism of human capital mobility is mainly observed within firms located in the same region; iii) the imitation-demonstration mechanism has a regional component, it is more common that firms observe and imitate other firms located in the same region; and iv) knowledge flows have a strong regional component, especially if tacit knowledge is involved.

2. Methodology

[8] Sjöholm (1999a) proved that competence within sectors affect the level of spillovers.

This research is based on information gathered from two surveys applied in Queretaro and Ciudad Juarez, Mexico, during 2005 and 2006. The sector analyzed is the machining sector industry. This is a traditional and mature sector were most of the firms are SMEs. They are suppliers of the automotive, home appliances, and electric electronic sectors. In Queretaro, 179 SMEs answered the questionnaire, about 80% of the firms. In Ciudad Juarez, 104 firms answered the questionnaire, about 72% of the SMEs in the sector. The information was analyzed by multivariate analysis techniques and structural equations analysis to identify the main knowledge spillover mechanisms and to explore their importance within the two localities.

This research focuses in two knowledge spillover mechanisms, backward linkages and human capital mobility, in particular the one associated to entrepreneurship (Table 2).

Table 2 Main variables to build knowledge spillover mechanisms

Mechanism	Variables	Queretaro	Ciudad Juarez	Type of variable
Human capital mobility (SMEs´ owners)	Years of previous experience		X	Numerical
	Experience in SMEs	X	X	Dichotomic
	Experience in medium firms	X	X	Dichotomic
	Experience in large firms	X	X	Dichotomic
	Experience in public research centers	X	X	Dichotomic
	Experience in government agencies	X	X	Dichotomic
	Experience in universities	X	X	Dichotomic
	Experience in maintenance	X	X	Dichotomic
	Experience in high management	X	X	Dichotomic
	Experience in machining	X	X	Dichotomic
	Experience in management	X	X	Dichotomic
	External training	X	X	Numerical
Backward linkages	Share design capacities	X	X	Discrete
	Share production capacities	X	X	Discrete
	Support the incorporation of new technologies	X	X	Discrete
	Support the plant set up	X	X	Discrete
	Share equipment	X	X	Discrete
	Access to large firms´ installations	X	X	Discrete
	Provide technical advise	X	X	Discrete
	Joint projects (products/process)	X	X	Discrete

	Share knowledge to export	X	X	Discrete
	SMEs´ employees training	X	X	Discrete
	Large firms accept SMEs recommendations	X	X	Discrete

Source: Author´s own. Surveys to SMEs located in Querétaro and Ciudad Juarez (UAM-X, 2005 and UACJ, 2005).

Note: Numeric variables are continuous.

Discrete variables have a Likert scale 1-5. Regarding importance: 1- low importance; 5- highly important. Regarding frequency: 1-rarely; 5-frequently.

Dichotomic variables are 1-Yes and 2-No.

We analyzed the human capital mobility mechanism by the following variables: owners´ years of experience, owners´ experience in large firms, owners´ managerial experience and owners´ formal and informal education.

The backward linkages mechanism is related to the following variables: years of the relationship, type of contracts, type of information shared during the relationship, and geographic proximity.

3. Different patterns of knowledge spillover mechanisms in Queretaro and Ciudad Juarez

We performed a principal factors technique of multivariate analysis to identify the most important variables related to the knowledge spillover mechanisms. We obtained the first order factors associated these mechanisms.

The explained variance for the analysis in Queretaro is 40.02% (Table 3). The explained variance in Ciudad Juarez is 64.10% (Table 4).

Table 3 Explained variance. Queretaro

Component	**Initial Eigen values**		
	Total	**% de Variance**	**% Accumulative**
1	5.585	25.387	25.387
2	3.219	14.634	40.020

Source: Author´s own. Surveys to SMEs located in Querétaro (UAM-X, 2005).

Extraction method: principal components.

Table 4 Explained variance. Ciudad Juarez

Component	Initial Eigen values		
	Total	**% de Variance**	**Total**
1	9.162	39.836	39.836
2	5.581	24.264	64.100

Source: Author´s own. Surveys to SMEs located in Ciudad Juarez (UACJ, 2005).

Extraction method: principal components.

Table 5 presents the rotated principal factor matrix for Queretaro and

Table 6 for Ciudad Juarez.

Table 5 Rotated factor matrix. Knowledge spillovers in Queretaro

Mechanism	**Variables**	**Descriptor**	**Factor 1**	**Factor 2**
Human capital mobility (SMEs´ owners)	Experience in SMEs	EPEQUEÑAS	.820	-.029
	Experience in medium firms	EMEDIANA	.796	-.051
	Experience in large firms	EGRANDE	.538	-.133
	Experience in public research centers	CENPÚBLICO	.932	-.080
	Experience in government agencies	DEPGUB	.962	-.040
	Experience in universities	UNIVERSIDAD	.918	-.016
	Experience in maintenance	MANTENI	.535	.153
	Experience in high management	GERENCIA	.637	.102
	Experience in machining	MAQYHERR	.429	.163
	Experience in management	ADMON	.584	.095
	External training	NUMCUREX	.133	.315
Backward linkages	Share design capacities	RCLIENTE1	.049	.629
	Share production capacities	RCLIENTE2	-.091	.528
	Support the incorporation of new technologies	RCLIENTE3	-.050	.696
	Support the plant set up	RCLIENTE4	.057	.466
	Share equipment	RCLIENTE5	.028	.447

Mechanism	Variables	Descriptor	Factor 1	Factor 2
	Access to large firms´ installations	RCLIENTE6	-.073	.343
	Provide technical advise	RCLIENTE7	-.020	.599
	Joint projects (products/process)	RCLIENTE8	.135	.574
	Share knowledge to export	RCLIENTE9	-.136	.240
	SMEs´ employees training	RCLIENTE10	.050	.568
	Large firms accept SMEs recommendations	RCLIENTE11	.206	.521

Author´s own. Surveys to SMEs located in Querétaro (UAM-X, 2005).

Extraction Method: Principal component analysis.

Rotation method: Varimax, Kaiser Normalization.

The rotation converged in 3 iterations.

Table 6 Rotated factor matrix. Knowledge spillovers in Ciudad Juarez

Mechanism	Variables	Descriptor	Factor 1	Factor 2
Human capital mobility (SMEs´ owners)	Years of previous experience	AÑOSEXPER	.679	.037
	Experience in SMEs	EPEQUEÑAS	.844	-.010
	Experience in medium firms	EMEDIANA	.850	.006
	Experience in large firms	EGRANDE	.837	-.009
	Experience in public research centers	CENPÚBLICO	.874	-.004
	Experience in government agencies	DEPGUB	.875	-.004
	Experience in universities	UNIVERSIDAD	.875	-.003
	Experience in maintenance	MANTENI	.898	.038
	Experience in high management	GERENCIA	.929	-.078
	Experience in machining	MAQYHERR	.896	-.129
	Experience in management	ADMON	.924	-.042
	External training	NUMCUREX	.366	-.168
Backward linkages	Share design capacities	RCLIENTE1	-.138	.802
	Share production capacities	RCLIENTE2	.041	.759
	Support the incorporation of new technologies	RCLIENTE3	-.141	.823
	Support the plant set up	RCLIENTE4	.827	.079
	Share equipment	RCLIENTE5	.042	.666
	Have access to large firms´ installations	RCLIENTE6	-.130	.818
	Provide technical advise	RCLIENTE7	.047	.850

Mechanism	Variables	Descriptor	Factor 1	Factor 2
	Joint projects (products/process)	RCLIENTE8	.081	.664
	Share knowledge to export	RCLIENTE9	-.010	.591
	SMEs´ employees training	RCLIENTE10	.031	.676
	Large firms accept SMEs recommendations	RCLIENTE11	-.089	.766

Author´s own. Surveys to SMEs located in Querétaro (UACJ, 2005).

Extraction Method: Principal component analysis.

Rotation method: Varimax, Kaiser Normalization.

The rotation converged in 3 iterations.

We can observe that the variables used in both localities have high factorial charges; therefore, they are highly correlated to the knowledge spillover mechanisms analyzed in this paper.

3.1. Human capital mobility: Entrepreneur mobility

We analyze the human capital mobility mechanism associated to entrepreneurship. Particularly we analyze the case of former employees that obtained knowledge and experience while working in other firms and started their own enterprises. Görg and Greenaway (2001) argue that this is an important spillover mechanism, as human capital is a direct mechanism of technology transfer. Vera-Cruz and Dutrénit (2005) emphasize the importance of creation of new firms by former maquiladora employees. The authors conclude that experience, but most important, the position of these former employees is determinant for knowledge spillovers, especially if the position was related to high management. The knowledge and experience that can be obtained by high management play an important role in SMEs productivity. De Fuentes and Dutrénit (2007) identified that human capital mobility is important only if associated to high management previous experience. Table 7 presents the previous experience of SMEs´ owners by type of organization.

Table 7 Owners´ experience by type of organization

Type of organization	Owners with experience in	
	Queretaro	Ciudad Juarez

	No.	**%**	**No.**	**%**
Small enterprise	14	7.8	23	22.1
Medium enterprise	20	11.2	13	12.5
Large firm (national/MNC)	127	70.9	73	70.2
Public research center	3	1.7	2	1.9
Government agency	0	0	1	1
University	1	0.6	1	1

Source: Author´s own. Surveys to SMEs located in Querétaro and Ciudad Juarez (UAM-X, 2005 and UACJ, 2005).

Sample: Queretaro: 179. Ciudad Juarez: 104

About 90% of SMEs´ owners in Queretaro have had experience in other organizations for 18 years in average. About 70% of employees have had experience in large firms.[9]

Ciudad Juarez presents the same phenomenon, about 88% of SMEs´ owners have had experience in other organizations, 70% of them had experience in maquiladoras and 64% worked for more than 6 years in those maquiladoras. While working in the maquiladoras, they identified a business opportunity and decided to start their own firms. Based on the results of both cases we can observe that large firms in Mexico, either national and MNC, promote the creation of SMEs.[10]

The specific activities performed by the former employees in large firms are important. The type of knowledge is specific if they developed technical or managerial activities. The experience of SMEs´ owners located in Queretaro and Ciudad Juarez is mainly related to production, operations, quality, maintenance, engineering and development. As we mentioned above, the experience in high management is important to develop strategic thinking, and to design plans and strategies for their new enterprises. The experience related to engineering and development is determinant to perform key activities in their new firms. In Queretaro 17% and in Ciudad Juarez 36% SMEs´ owners had experience in

[9] Survey to SMEs located in Querétaro (UAM-X, 2005).

[10] Interviews with Fernando Curiel and Agustín Martínez (CIATEQ, 2004); Vicente Bringas (CIDESI, 2004); and Pedro Felisart (Condumex, 2004). See also Dutrénit and Vera-Cruz (2003).

this type of positions (Table 8).[11] However, only 4% of the SMEs´ owners in Queretaro and 1% in Ciudad Juarez had this type of experience.

Table 8 Position by former employees in large firms

Position	Owners with experience in			
	Queretaro		Ciudad Juarez	
	No.	%	No.	%
High management	7	4.5	1	1.1
Engineering and development	27	17.2	33	35.9
Management activities, supply and sales	12	7.6	4	4.3
Quality and maintenance	9	5.7	7	7.6
Production and operations	52	33.1	39	42.4

Source: Author´s own. Surveys to SMEs located in Querétaro and Ciudad Juarez (UAM-X, 2005 and UACJ, 2005).

Sample: Queretaro: 179. Ciudad Juarez: 104

Table 9 and

Table 10 present the correlation matrix for the human capital mechanism in both localities. Human capital mobility related to the experience in large firms is more significant in Ciudad Juarez than Queretaro. Experience in medium firms is more significant in Queretaro. Previous experience in management is more significant in Ciudad Juarez than in Queretaro.

Table 9 Correlation matrix. Human capital mobility in Queretaro

	EPEQUEÑAS	EMEDIANA	EGRANDE	CENPÚBLICO	DEPGUB	UNIVERSIDAD	MANTENI	GERENCIA	MAQYHERR	ADMON	Movilidad de CH
EPEQUEÑAS	1	.650	.232	.800	.842	.779	.333	.381	.250	.345	.820
EMEDIANA	.650	1	.288	.752	.794	.732	.288	.406	.275	.336	.796

[11] Dutrénit, *et. al*. (2003) and Vera-Cruz and Dutrénit (2005).

EGRANDE	.232	.288	1	.546	.586	.560	.203	.191	.163	.224	.538
CENPÚBLICO	.800	.752	.546	1	.959	.893	.406	.456	.281	.396	.932
DEPGUB	.842	.794	.586	.959	1	.933	.383	.482	.320	.423	.962
UNIVERSIDAD	.779	.732	.560	.893	.933	1	.395	.444	.274	.386	.918
MANTENI	.333	.288	.203	.406	.383	.395	1	.517	.267	.465	.535
GERENCIA	.381	.406	.191	.456	.482	.444	.517	1	.382	.679	.637
MAQYHERR	.250	.275	.163	.281	.320	.274	.267	.382	1	.290	.429
ADMON	.345	.336	.224	.396	.423	.386	.465	.679	.290	1	.584
Movilidad de CH	.820	.796	.538	.932	.962	.918	.535	.637	.429	.584	1

Source: Author´s own. Surveys to SMEs located in Querétaro (UAM-X, 2005).

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 10 Correlation matrix. Human capital mobility in Ciudad Juarez

	AÑOSEXPER	EPEQUEÑAS	EMEDIANA	EGRANDE	CENPÚBLICO	DEPCUB	UNIVERSIDAD	MANTENI	GERENCIA	MAQYHERR	ADMON	NUMCUREX	Movilidad de CH
AÑOSEXPER	1	.522	.511	.483	.625	.631	.626	.615	.627	.572	.618	.234	.670
EPEQUEÑAS	.522	1	.918	.883	.768	.807	.807	.751	.813	.744	.797	.378	.872
EMEDIANA	.511	.918	1	.889	.784	.829	.835	.770	.829	.765	.825	.327	.885
EGRANDE	.483	.883	.889	1	.715	.765	.758	.769	.758	.701	.757	.244	.837
CENPÚBLICO	.625	.768	.784	.715	1	.989	.989	.910	.989	.959	.979	.406	.968
DEPGUB	.631	.807	.829	.765	.989	1	.993	.915	.993	.956	.983	.423	.982
UNIVERSIDAD	.626	.807	.835	.758	.989	.993	1	.909	.993	.956	.990	.418	.982
MANTENI	.615	.751	.770	.769	.910	.915	.909	1	.909	.843	.898	.287	.925
GERENCIA	.627	.813	.829	.758	.989	.993	.993	.909	1	.956	.983	.416	.980
MAQYH	.572	.744	.765	.701	.959	.956	.956	.843	.956	1	.944	.433	.939

	AÑOSEXPER	EPEQUEÑAS	EMEDIANA	EGRANDE	CENPÚBLICO	DEPCUB	UNIVERSIDAD	MANTENI	GERENCIA	MAQYHERR	ADMON	NUMCUREX	Movilidad de CH
ERR													
ADMON	.618	.797	.825	.757	.979	.983	.990	.898	.983	.944	1	.397	.974
NUMCUREX	.234	.378	.327	.244	.406	.423	.418	.287	.416	.433	.397	1	.418
Movilidad de CH	.670	.872	.885	.837	.968	.982	.982	.925	.980	.939	.974	.418	1

Source: Author´s own. Surveys to SMEs located in Ciudad Juarez (UACJ, 2005).

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

3.2. Backward linkages

Backward linkages knowledge spillovers depend to a certain degree by the large firms´ strategy. SMEs located in Queretaro have been suppliers of large firms for 6 years in average, while in Ciudad Juarez they have been suppliers for 7 years in average. Formal contracts among SMEs and large firms are not frequent. This can represent a barrier for SME in terms of strategic and financial decisions.

The information diffused through this mechanism is important to determine the type of knowledge flowing among firms. If we analyze Queretaro, we can observe that the most common activities are related to: i) access to large firms´ installations; ii) SMEs provide recommendations to improve product design; and iii) they share design and production capacities. On the other hand, the most important activities related to this mechanism in Ciudad Juarez are: i) share knowledge to export; ii) support the plant set up; and iii) training of SMEs employees. The emphasis in different activities can be explained by the industrial arrangement in both localities. Ciudad Juarez is a border city and is exposed to a higher number of foreign firms located either in Mexico or US. Such interaction has had an important impact on the sector dynamics. The development of exportation capacities in Ciudad Juarez strengthens their organizational capacities at the same time, and they can have access to more demanding markets. Table 11 and Table 12 present the correlation matrix for both localities.

Table 11 Correlation matrix. Backward linkages in Queretaro

	NUMCUREX	RCLIENTE1	RCLIENTE2	RCLIENTE3	RCLIENTE4	RCLIENTE5	RCLIENTE6	RCLIENTE7	RCLIENTE8	RCLIENTE9	RCLIENTE10	RCLIENTE11	VINCULO
NUMCUREX	1	.002	-.028	.035	.151	.095	-.016	.152	.030	-.027	.193	.081	.315
RCLIENTE1	.002	1	.496	.371	.114	.148	.179	.266	.452	.128	.226	.338	.629
RCLIENTE2	-.028	.496	1	.486	.144	.213	.148	.184	.180	.161	.248	.163	.528
RCLIENTE3	.035	.371	.486	1	.366	.261	.227	.301	.335	.174	.300	.303	.696
RCLIENTE4	.151	.114	.144	.366	1	.233	.086	.210	.120	.231	.274	.091	.466
RCLIENTE5	.095	.148	.213	.261	.233	1	.041	.263	.144	.070	.190	.165	.447
RCLIENTE6	-.016	.179	.148	.227	.086	.041	1	.246	.151	.052	.183	.117	.343
RCLIENTE7	.152	.266	.184	.301	.210	.263	.246	1	.293	.111	.458	.257	.599
RCLIENTE8	.030	.452	.180	.335	.120	.144	.151	.293	1	.151	.200	.371	.574
RCLIENTE9	-.027	.128	.161	.174	.231	.070	.052	.111	.151	1	.214	.117	.240
RCLIENTE10	.193	.226	.248	.300	.274	.190	.183	.458	.200	.214	1	.208	.568
RCLIENTE11	.081	.338	.163	.303	.091	.165	.117	.257	.371	.117	.208	1	.521
VINCULO	.315	.629	.528	.696	.466	.447	.343	.599	.574	.240	.568	.521	1

Source: Author´s own. Surveys to SMEs located in Querétaro (UAM-X, 2005).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 12 Correlation matrix. Backard linkages in Ciudad Juárez

	RCLIENTE1	RCLIENTE2	RCLIENTE3	RCLIENTE4	RCLIENTE5	RCLIENTE6	RCLIENTE7	RCLIENTE8	RCLIENTE9	RCLIENTE10	RCLIENTE11	VINCULOS
RCLIENTE1	1	.566	.697	-.072	.458	.761	.642	.485	.324	.399	.594	.802
RCLIE	.566	1	.534	.117	.406	.484	.558	.534	.557	.585	.443	.759

NTE2												
RCLIENTE3	.697	.534	1	-.106	.606	.676	.658	.452	.412	.439	.628	.824
RCLIENTE4	-.072	.117	-.106	1	.101	-.051	.122	.097	.048	.080	-.059	.074
RCLIENTE5	.458	.406	.606	.101	1	.570	.557	.300	.210	.400	.407	.666
RCLIENTE6	.761	.484	.676	-.051	.570	1	.645	.417	.362	.403	.718	.818
RCLIENTE7	.642	.558	.658	.122	.557	.645	1	.590	.440	.532	.639	.850
RCLIENTE8	.485	.534	.452	.097	.300	.417	.590	1	.370	.396	.437	.665
RCLIENTE9	.324	.557	.412	.048	.210	.362	.440	.370	1	.526	.350	.590
RCLIENTE10	.399	.585	.439	.080	.400	.403	.532	.396	.526	1	.443	.676
RCLIENTE11	.594	.443	.628	-.059	.407	.718	.639	.437	.350	.443	1	.767
VINCULO	.802	.759	.824	.074	.666	.818	.850	.665	.590	.676	.767	1

Source: Author´s own. Surveys to SMEs located in Ciudad Juarez (UACJ, 2005).

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

This type of knowledge spillovers presents a higher correlation for Ciudad Juarez than Queretaro. In both localities analyzed, large firms have established support linkages to SMEs, which has been an important factor to increase their technological and organizational capacities.

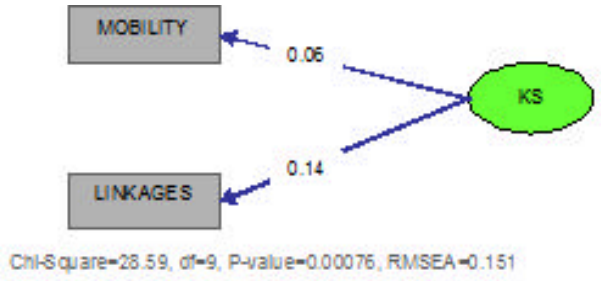
3.3. Patterns of knowledge spillover mechanisms

We performed a structural equations analysis to identify the importance of each one of the knowledge spillover mechanisms analyzed in both localities (Figure 2 and Figure 3). We identify that the variables that we use for this analysis explain a small part of large firms´ knowledge spillovers to SMEs. Each of the mechanisms that were analyzed explains less than 20% of the knowledge spillover mechanisms.

On one hand, in Queretaro, the 6% of the human capital mobility mechanism, and the 14% of backward linkages mechanism explain large firms´ knowledge spillovers (Figure 2). The

backward linkages mechanism is the most important type of spillovers in Queretaro. This can be explained by the fact that SMEs are strongly dependant of large firms' evolution.

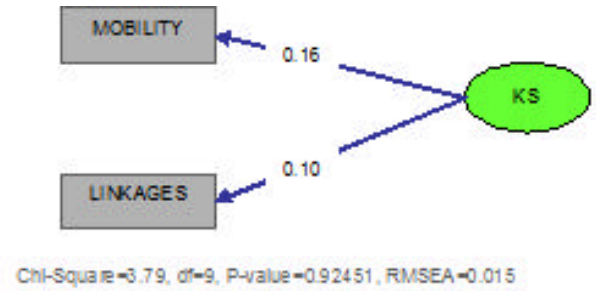
Figure 2 Structural equations model. Knowledge spillovers in Queretaro



Source: Author´s own. Surveys to SMEs located in Querétaro (UAM-X, 2005).
Software: LISREL

On the other hand, in Ciudad Juarez, the 16% of human capital mobility and 10% of backward linkages mechanisms explain large firms´ knowledge spillovers (Figure 3). The most important spillover mechanism in Ciudad Juarez is the human capital mobility associated to entrepreneurship.

Figure 3 Structural equations model. Knowledge spillovers in Ciudad Juarez



Source: Author´s own. Surveys to SMEs located in Ciudad Juarez (UACJ, 2005).
Software: LISREL

The backward linkages mechanism benefits SMEs in both localities. Those benefits are mainly associated to the understanding of their clients´ processes, knowledge sharing to improve product design and direct technology transfer.

In regard the human capital mobility mechanism, the low level of knowledge spillovers can be explained by the lack of formal education of SMEs´ owners. This lack of formal education is a barrier for the absorption of new knowledge and its future use in the new firms. Without formal education employees can not perform higher positions related to organizational or managerial activities in large firms. Most of the SMEs´ owners acquired experience in machining, production, maintenance and quality. They acquired abilities to establish an efficient production process, but they did not acquired organizational capacities to manage their new firms successfully.

To sum up, both localities present different patterns of knowledge spillovers. The most important knowledge spillover mechanism in Queretaro is backward linkages, which suggest a strong dependency between SMEs and their customers. Most of the variables that we analyzed are related to the large firms´ activities to strengthen SMEs´ production and technological capacities. On the other hand, the most important mechanism in Ciudad Juarez is associated to human capital mobility; this can be associated to the higher significance of experience in large firms for knowledge spillovers.

The importance of this knowledge spillover mechanism refers to the acquisition of technical and organizational experience. There is an additional effect associated to this mechanism, the linkages established among owners and their former employers. There is common knowledge related to culture, production techniques and product specifications, and the experience embedded in the SMEs´ owners is a plus when they try to establish backward linkages with their former employers.

4. Conclusions

The main aim of this paper was to analyze two large firms´ knowledge spillover mechanisms to SMEs that belong to the machining industry sector, and identify the

differences in two localities. This comparative analysis suggest that knowledge spillovers are sector specific, and geographic specific. The context and productive arrangement can modify the patterns of knowledge spillovers.

We focused in two knowledge spillover mechanisms: backward linkages and human capital mobility. Using direct and customized indicators to analyze knowledge spillovers we proved with empirical data the existence and importance of two knowledge spillover mechanisms discussed by other authors (Blomström and Sjöholm 1998; Blomström and Kokko, 2003; Chudnovsky, *et al*, 2003; Jordaan, 2005; Vera-Cruz and Dutrénit, 2005; and Marin and Bell, 2006).

Knowledge spillovers diffused through backward linkages are affected by large firms´ supplier strategy. The SMEs analyzed have an average relationship of 6 years with their clients and they usually do not establish formal contracts. This type of spillovers focuses on strengthening SMEs´ production capacities to reach customers demands. In both localities, large firms have established support linkages with SMEs to share design and production capacities. SMEs have to keep developing and strengthening their organizational and technical capacities to increase their market shares.

In regard the human capital mobility mechanism, we focus on the owners´ formal education and experience, both technical and organizational. In both localities, some of the former employees got their experience in medium and large firms and decided to establish their own firm. The position they had in other firms determines the knowledge complexity they absorbed and transfer to their new firms. In both of the localities, the owners have had experience in production, quality and maintenance. Although high management experience is important for this type of spillovers, a small percent of SMEs´owners have had experience in this type of activities.

We found different patterns of knowledge spillovers in both of the localities analyzed. On one hand, in Querétaro the most important knowledge spillover mechanism is related to backward linkages. SMEs are strongly dependant on their customers' demands and

evolution. To promote this type of spillovers we suggest strengthening backward linkages and the type of knowledge that is flowing. We also suggest strengthening SMEs´ production and technological capacities to reach customers demands. On the other hand, in Ciudad Juarez the most important mechanism is related to the human resources mobility. This finding supports the research made by Görg and Greenaway (2001) and Vera-Cruz and Dutrénit (2005). This result suggests that previous experience in large firms is determinant for knowledge spillovers. To strengthen this type of knowledge spillover we suggest focus on strengthening SMEs´ organizational capacities, as most of the owners possess technical knowledge, but they lack organizational abilities. These different patterns suggest that context and the type of productive arrangement established among firms in the same locality influence knowledge spillovers.

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